Udacity SDC
Term 2
PID Controller
Project Write up

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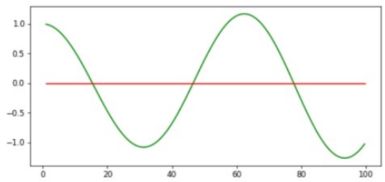
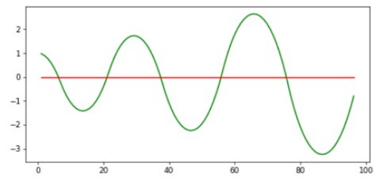
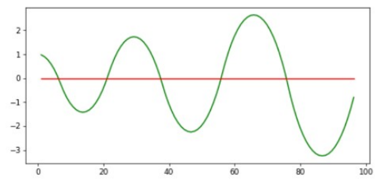
PID Controller
The goal of this project is to implement a PID controller onto the track of the simulator.

Code Review.

The code to review is into main.cpp and pid.cpp, after the mentions TODO. The main explanation I will procure in this note, is how I used to tune the P, I and D parameters.

For, this, instead of embedding videos, I will use the lesson 16, chapter 11 to show what the parameter tuning were doing on my vehicle.

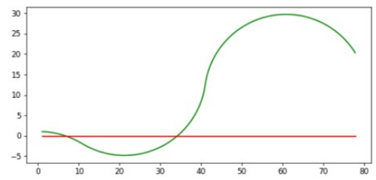
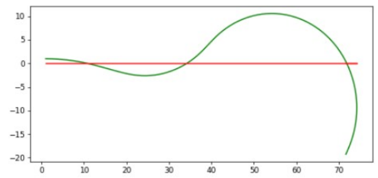
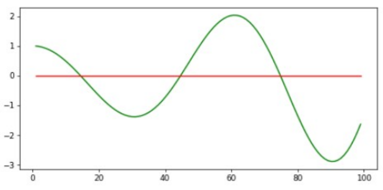
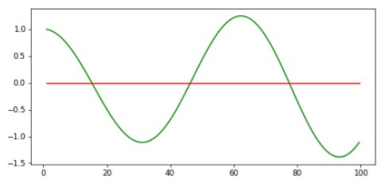
1. Proportional:
   So, initially I set up all the parameters to 1, and then I saw the car was oscillating a lot around center line, so I decided to get back to the lesson 16 chapter 11, where there is a graph of the impact of each parameter. I started to play with Kp parameter, the proportional one, and setting Kd and Ki to 0. I played with Kp around order of magnitudes to understand how the variable was impacting behaviour. I saw the following on the graph:

Kp	Effect	Note
0.2		Vehicle oscillates around middle line
2		Steering amplifies and gets out of control
20		Steering amplifies and gets out of control

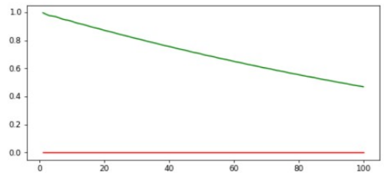
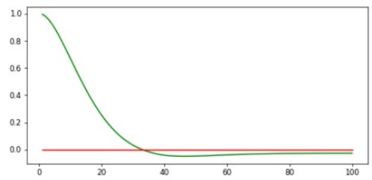
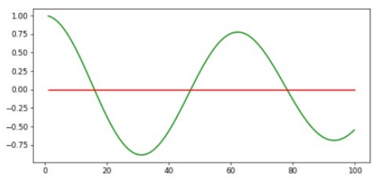
By playing with the controller for the project, I realized that the 0.5 threshold was pretty accurate.

2 Integral

The project hasn't an original offset, and none of the parameters except 0 where giving a good result. However, the table below shows the implication of Integral parameter tuning.

Ki	Effect	Note
0.4		Out of control steering
0.04		Converges on the first oscillation and then gets out of control
0.004		Start to show signs on convergence
0.0004		Converges again, but gets slightly out of control on 100 iterations

3 Derivative.
Similar as both parameters above, I tuned the parameter Kd to understand it's impliaction.

Kd	Effect	Note
30		Super stiff steering, converges very slowly
3		Removes oscillation and converges after 1 oscillation (after passing the middle lane)
0.3		Too loose. The parameter is not high enough and dampers the oscillations very slowly.

After applying this tuning to the project, I found out that the following parameter were the most accurate for my controller.

Kp = -0.5
Ki = 0
Kd = -10